

Correlation between serological results from Level 3 herds in the Danish Salmonella Surveillance and Control Programme and swab samples from carcasses from the same herd.

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Introduction

One of the elements of the Danish Salmonella Surveillance and Control Programme is surveillance of slaughter-pig herds. All herds delivering more than 100 slaughter pigs per year are included in the surveillance. At the slaughterhouses meat samples are collected randomly according to the legislation from the Danish Veterinary Service. The meat samples are analysed at The Danish Veterinary Laboratory for the presence of specific *Salmonella* antibodies by a indirect enzyme-linked immunosorbent assay, the so-called mix-ELISA (1). The results of the analysis are registered in the Zoonosis data base owned by the Danish Ministry of Food, Agriculture and Fisheries. The results are registered under the herd specific Central Herd Register (CHR) number.

Depending on the prevalence of sero-positive samples from the last three months the herds are assigned to one of three levels. Level 3 includes the herds with the highest proportion of reactors, and in addition to herd intervention pigs are slaughtered under special hygienic precautions. This means, that the pigs are delivered to the slaughterhouse as late as possible on the day of slaughter, plucks and gutsets are condemned and the slaughter hygiene is followed by swab samples taken randomly from the carcasses. With one gauze pad the medial part of the ham, meat and approximately 5 cm of skin and the pelvic cavity is swabbed, with another gauze pad the total abdominal and breast cut together with 5 cm of skin is swabbed. In total an area of 1400 cm². The two samples are pooled and analysed for the presence of *Salmonella* bacteria. If more than 25 pct. of the samples are positive, the entire batch of carcasses are referred to heat treatment or curing.

The slaughterhouse is allowed to devide the pigs from Level 3 herds in groups, but each group must be tested with a sufficient number of samples. If a group of pigs is predetermined to heat treatment or curing, no swab testing is required. To minimize the number of carcasses which must be heat treated the slaughterhouses need a tool to predict the risk of *Salmonella* contamination of the carcasses from each Level 3 herd.

Materials and Methods

At the Tican slaughterhouse the CHR number is registered together with the swab samples, so the herd of origin is known for each swab sample. In this study all swab samples from the years 1997 and 1998 have been matched with the meat juice sero-prevalence for the same period. The study has included a total of 3443 swab samples representing 361 batches of pigs slaughtered on 191 days, and originating from 55 Level 3 herds.

Statistical Method

It was investigated, whether sero-prevalence of meat juice samples sampled on the slaughterday, the previous week (week -1) and 2 weeks earlier (week -2) from pigs from the same herd could be a predictor for the *Salmonella* positive swabs sampled from carcasses originating from the same herd. Meat juice sero-prevalence was used as a predictor as a continuous variable and as a class-variable divided into different strata of prevalences in an attempt to investigate, whether there was a specific prevalence, that could be used as a cut-off from a practical point of view.

The applied method was logistic regression, using generalized equation estimation (GEE) to control for the effect of day of slaughter and the possible correlation between results from herds slaughtered on the same day.

Results

The first model investigated was the association between meat juice sero-prevalence as a continuous variable and carcass-swab *Salmonella*-positivity for the following predictors, prevalence on the slaughterday, week -1 and week -2.

The results are shown in table 1.

Table 1: Association between meat juice sero-prevalence and prevalence of Salmonella positive swab samples.

	Predictor meat juice sero-prevalence		
	Slaughterday	Week -1	Week -2
OR (approx. RR) for 100 % meat-juice sero-prevalence	1,48 (0.89-2.65)	2,37 (1.49-3.98)	1,48 (0.87-2.32)
1 %	1	1	1
P-value	0.13	0.0004	0.16

Table 2: Carcass-swab Salmonella-prevalence predicted by the meat juice sero-prevalence.

Meat juice sero-prevalence	Based on slaughterday		Based on week -1		Based on week -2	
	Carcass-swab prevalence % (C. I.)	Observations	Carcass-swab prevalence % (C. I.)	Observations	Carcass-swab prevalence % (C. I.)	Observations
0 positive	9 (7-13)	190	7 (5-19)	172	9 (7-12)	168
0<=<=10 % prevalence	-	0	-	0	-	0
10<=<=25 % prevalence	13 (6-22)	15	10 (6-18)	15	20 (10-37)	11
25<=<=50 % prevalence	8 (5-13)	60	11 (7-19)	57	7 (4-12)	62
>50 % prevalence	14 (10-20)	96	15 (11-22)	117	13 (9-18)	120

Meat juice sero-prevalence in week -1 was found to be the strongest predictor of bacteriology the following week. Higher meat juice sero-prevalences from week -1 results in an increase in the prevalence of salmonella-positive carcasses. Results from the slaughterday were not as strong, and results from week -2 were also less efficient as predictors, although the wide confidence intervals indicate, that judging the predictors to be significantly different from each other is not possible.

In table 2 is shown the average prevalence of carcasses from herds with different stratified prevalences. Results are shown for sero-prevalence at the slaughterday, week -1 and week -2.

Higher meat juice sero-prevalences were associated with higher number of Salmonella positive carcass-swabs for all 3 predictors. The result from the 10-25 % group is based on a small sample-size, and should not be seen as an important result.

The correlation between results on carcass-swabs between herds slaughtered on the same day

was 9.24, 0.21 and 0.25 indicating a strong correlation between carcasses from different herds slaughtered on the same day.

Dividing the herds into two groups based on meat juice sero-prevalence from week -1 and results from week -2, with one group being negative on both samples, and the other group having positive samples on at least one of the days predicts an average carcass prevalence on 7 (5-11) in the low group (110 herds), and an average carcass prevalence on 12 (9-15) from the high group (251 herds). The difference is significant ($p=0.03$).

Discussion

In this study we found an association between the meat juice sero-prevalence and the risk of a carcass being *Salmonella* positive, when meat juice sero-prevalence from the herd of origin was used as a predictor of *Salmonella*-positivity of carcasses from the same herd. The correlation between herds slaughtered on the same day suggests, that cross-contamination between carcasses from different herds is a significant factor. Alternatively the correlation could be due to day to day fluctuations in the general hygiene level on the slaughterhouse. If low prevalence Level 3 herds were to be slaughtered separately from the high prevalence Level 3 herds, a greater difference between the herds could be the result, when considering the high correlation between the carcass-swab results from herds slaughtered on the same day.

The meat juice sero-prevalence is estimated on a small number of samples (some herds have only 1 meat juice sample). Increasing the number of meat juice samples would increase the precision in the estimation and could lead to a better differentiation between 'high risk' Level 3 herds and 'low risk' Level 3 herds.

It is important to remember, that herds in this study are Level 3 herds, that are assigned high-risk herds and slaughtered as such. Level 3 herds constitute less than 1 pct. of the Danish slaughter pig herds.

This is a small study, but it confirms the correlation between the prevalence of specific *Salmonella* antibodies found in meat-juice samples from a herd and the prevalence of *Salmonella* bacteria in pigs from the same herd. This ensures, that the herds assigned to Level 3 are the herds of high risk regarding *Salmonella* contamination. In the Danish surveillance of slaughter pig herds, herds are assigned to a level depending on the plain average of the meat-juice samples taken during the previous three month. As a consequence some Level 3 herds will have a low monthly prevalence before it will be assigned to a lower level. These herds will be of minor risk of causing *Salmonella* contamination at slaughter.

The primary aim when slaughtering pigs from Level 3 is to produce pork, which does not pose a risk of causing food-borne human salmonellosis. Secondly the slaughterhouses wants to reduce the numbers of carcasses, which must be heat treated. Both aims can be achieved by minimizing the risk of *Salmonella* contamination by slaughtering the most infected pigs as the last batch on that particular day. The results of this study show that the meat juice sero-prevalence in samples taken one and two weeks before slaughter might be a usefull tool when dividing the pigs into groups, that can be slaughtered without *Salmonella* contamination and groups that may be *Salmonella* contaminated.

References

1. Nielsen, B., D.L. Baggesen, F. Bager, J. Haugegaard, and P. Lind. 1995. The serological response to *Salmonella* serovars typhimurium and infantis in experimentally infected pigs. The time course followed with an indirect anti-LPS ELISA and bacteriological examination. *Vet. Microbiol.*, 47: 205-218.